PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of:

Applicant	:	Nicholas Paul Cowley et al.
Serial No.	:	09/935,028
Filed	:	August 22, 2001
Title	:	DIGITAL TUNER
Docket No.	:	534334-014

Commissioner for Patents
Washington, D.C. 20231

SUBMISSION OF PRIORITY DOCUMENT

Pursuant to the claim for priority under 35 U.S.C. §119 made in the Declaration in the above-identified application, the following priority document is submitted:

Country	Application No.	Filing Date
Great Britain	0020527.8	August 22, 2000

No fee is required. The Commissioner is authorized to charge any additional fees required by this paper (including the fee for any additional extension of time) or to credit any overpayment to Deposit Account No. 20-0809.

Respectfully submitted:

Date: December 17, 2001

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Signed M Cuckie

Dated 21 August 2001

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1.	Your reference	JSR.P51134GB
2.	Patent application number *(The Patent Office will fill in this part)*	0020527.8 22 AUG 2000
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	Mitel Semiconductor Limited Cheney Manor Swindon Wiltshire SN2 2QW
	Patents ADP number *(if you know it)*	7387442001
	If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom
4.	Title of the invention	Digital Tuner
5.	Name of your agent *(if you have one)*	Marks & Clerk
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Description	5
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Priority documents	
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Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	
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Date 21 August, 2000

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DIGITAL TUNER

The present invention relates to a digital tuner, for example for receiving cable or terrestrial signals over a wide tuning range.

Known types of digital tuners are of single conversion or double conversion types. In the single conversion type, the incoming signal is converted to a fixed intermediate frequency (IF) which is sufficiently low for the received signals to be digitised and then demodulated in the digital domain. Double conversion tuners convert the incoming signal to a first intermediate frequency signal, which is then converted to a second intermediate frequency signal sufficiently low to permit digitisation and demodulation.

Another known type of tuner is of the direct conversion or zero IF type, in which the incoming signal is converted directly to the baseband signal in a single frequency conversion step and is then digitised and demodulated. Zero IF tuners are generally used where the tuning range of the tuner is narrow relative to the frequencies of the incoming signals. For example, in DBS (Direct Broadcast Satellite) systems, the tuning range or received frequency range is from 950 to 2150 MHz so that the tuning range is 200 MHz and is relatively narrow compared with the frequencies of the signals to be received within this range.

Zero IF tuners are not readily suitable for applications where the tuning range is relatively large compared with the received signal frequencies. For example, in cable or terrestrial tuners, the tuning range is typically 50 to 900 MHz. When the tuner is tuned to one of the lower channels of such a large tuning range, there are a significant number of channels at harmonics of the tuned frequency. The mixer function within a zero IF tuner is generally highly non-linear so that there is the substantial risk of channels at frequencies which are integer multiples of the tuned frequency also to be converted to the zero IF and hence of causing substantial interference, possibly rendering the technique unusable.

According to the invention, there is provided a digital tuner having a tuning range with a lower frequency limit f_1 and an upper frequency limit f_2, the tuner comprising an upconverter for converting an input signal to an intermediate frequency signal whose frequency is higher than the frequency of the input signal and a downconverter for converting the intermediate frequency signal to a substantially zero intermediate frequency signal, the upconverter having a local oscillator fundamental frequency which is greater than f_2.

An intermediate frequency filter may be disposed between the upconverter and the down converter.

The downconverter may be a quadrature down converter.

The upconverter may be a variable upconverter for selecting a desired channel and the downconverter may be a substantially fixed down converter. As an alternative, the upconverter may be a fixed upconverter and the downconverter may be a variable downconverter for selecting a desired channel.

The upconverter may be arranged to convert the tuning range to a frequency range of $(f_1 + f)$ to $(f_2 + f)$, where $(f_2 + f)$ is less than $2 (f_1 + f)$.

It is thus possible to provide a tuner which permits conversion to zero IF or near –zero IF without substantially suffering from problems associated with channels at harmonic or integer multiple frequencies of the tuned channel or frequency. In particular, the up conversion may be performed such that the range of frequencies supplied to the downconverter is small compared with the actual frequency. It is readily possible to perform the up conversion so that the upper limit of the frequency range is below the second harmonic of the lower limit of the frequency range so that no channels exist at any harmonic frequency of any tuned channel within the up-converted frequency range.

The present invention will be further described, by way of example, with reference to the accompanying drawing, which illustrates a broad band digital tuner constituting an embodiment of the invention.

The tuner comprises an antennae input, which may be connected to a cable distribution system, to an aerial or aerial distribution system for terrestrial broadcast signals, or to a satellite dish via a head unit for converting the received frequency range to a lower frequency range. For example, in the case of cable or terrestrial signals, the received frequency range, and hence the required tuning range of the tuner, may typically be from 50 to 860 MHz.

The antennae input is connected to an upconverter 1. The upconverter 1 may be of the type which performs a fixed conversion such that the whole of the frequency range is up converted to a higher frequency range without selecting the desired channel. For example, for the above-mentioned typical tuning range of 50 to 860MHz, the upconverter local oscillator frequency may be 1.05GHz and the intermediate frequency bandwidth is then 1.1 to 1.96 GHz. Alternatively, the upconverter may be of the type which selects the desired channel for reception and converts this to a higher intermediate frequency. In this case, for the same tuning range, the upconverter local oscillator frequency may be tunable between 1.15 and 1.96GHz to give an intermediate frequency centred on 1.1GHz.

The output of the upconverter 1 is connected to an intermediate frequency filter 2 of the bandpass type. Where the upconverter 1 is of the fixed type, the filter 2 has a wide bandwidth substantially equal to the tuning range of the tuner e.g. 810MHz. Alternatively, where the converter 1 is of the variable type, the filter 2 may have any bandwidth from the tuning range to the bandwidth of each channel within the tuning range and may typically have a bandwidth greater than the channel bandwidth by an amount to allow for discrete upconverter tuning step size and frequency accuracy.

The output of the filter 2 is connected to a quadrature downconverter 3 of the zero intermediate frequency type. Where the upconverter 1 is of the fixed type, channel selection is performed in the downconverter 3, which has a variable frequency local oscillator for selecting the desired channel to be down-converted. For the above example, the downconverter local oscillator frequency is tunable between 1.1 and 1.96GHz.

Where the upconverter 1 is of the variable type and has a variable local oscillator as opposed to a fixed frequency local oscillator, the downconverter 3 is of the substantially fixed type and has a fixed frequency local oscillator for converting the already-selected channel to zero IF or base band. For the above example, the downconverter local oscillator frequency is 1.1GHz and may be tunable over a small range to allow compensation for any tuning inaccuracy, for example resulting from the discrete upconverter tuning step size.

The downconverter 3 supplies in-phase base band signals at an I channel output and quadrature base band signals at a Q channel output. The signals at the outputs may then be digitised and demodulated in the digital domain by known techniques, for example as disclosed in the DVBT reference D-book.

Where the lower and upper limits of the tuning range at the input of the tuner are given by f_1 and f_2, respectively, it may be advantageous to ensure that the corresponding frequency range after up-conversion is given by $(f_1 +f)$ and $(f_2 +f)$ such that $(f_2 +f)$ is less than $2 (f_1 +f)$. This is particularly so for the case of a fixed upconverter with no or only limited intermediate frequency filtering between the upconverter and the downconverter.

It is thus possible to ensure that the zero IF down-conversion can be achieved, even when this down-conversion is performed by a mixer of highly non-linear type. In particular, by appropriately selecting the up-conversion and hence the intermediate frequency presented to the downconverter 3 relative to the tuning range, it can be ensured that, for every channel within the tuning range, there are no channels at

harmonics or integer multiple frequencies. Thus, a major source of interference in zero IF down-conversion can be eliminated or substantially reduced so as to make the technique viable.

CLAIMS:

1. A digital tuner having a tuning range with a lower frequency limit f_1 and an upper frequency limit f_2, the tuner comprising an upconverter for converting an input signal to an intermediate frequency signal whose frequency is higher than the frequency of the input signal and a downconverter for converting the intermediate frequency signal to a substantially zero intermediate frequency signal, the upconverter having a local oscillator fundamental frequency which is greater than f_2.

2. A tuner as claimed in claim 1, in which an intermediate frequency filter is disposed between the upconverter and the downconverter.

3. A tuner as claimed in claim 1 or 2, in which the downconverter is a quadrature downconverter.

4. A tuner as claimed in any one of the preceding claims, in which the upconverter is a variable upconverter for selecting a desired channel and the downconverter is a substantially fixed downconverter.

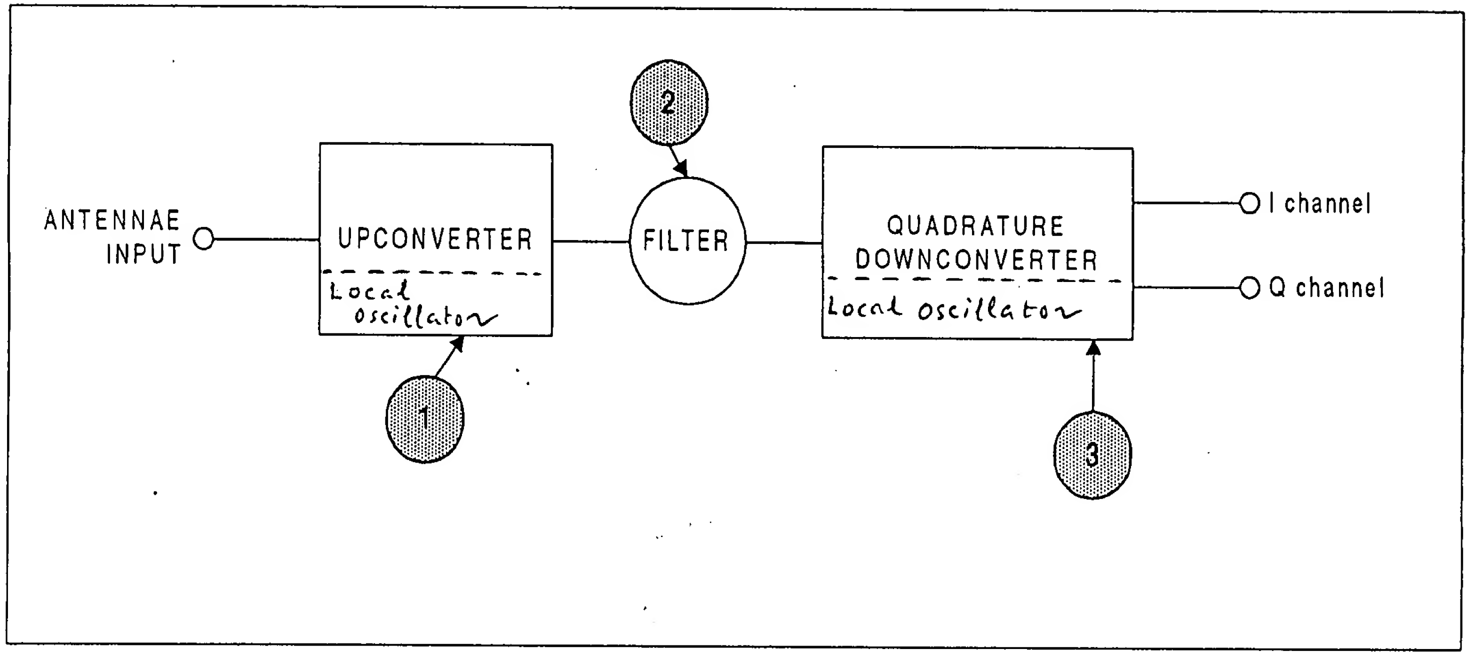
5. A tuner as claimed in any one of claims 1 to 3, in which the upconverter is a fixed upconverter and the downconverter is a variable downconverter for selecting a desired channel.

6. A tuner as claimed in any one of the preceding claims, in which the upconverter is arranged to convert the tuning range to a frequency range of $(f_1 + f)$ to $(f_2 + f)$, where $(f_2 + f)$ is less than $2(f_1 + f)$.

ABSTRACT

DIGITAL TUNER

A digital tuner comprises an upconverter 1 for converting an input signal to a higher intermediate frequency signal. The intermediate frequency signal is filtered by a filter 2 and supplied to a downconverter 3 which converts the intermediate frequency signal to baseband or a zero IF signal. The upconversion may be selected such that there are no channels at harmonic frequencies of any channel within the tuning range.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